# FIVE NEUROIMAGING-INFORMED TOPICS

## That Every Child and Adolescent Psychiatrist Should Know and Discuss With Patients

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Most child and adolescent psychiatrists have, at one time or another, found themselves explaining why ordering a brain scan won't actually diagnose or help treat the child sitting in their office. The clinician often attempts to explain to the child's family how neuroimaging is primarily useful in research settings and that we are not yet at a stage where it can be used to diagnose an individual child. This may leave many wondering what utility brain imaging actually has for the core mission of our profession: treating children with psychopathology. Listening to talks by neuroscience leaders in recent years has also become disheartening: researchers are still far from understanding the neurobiological basis for most psychiatric disorders. Nevertheless, there are ways in which child and adolescent psychiatric brain imaging research can inform our current clinical practice.

In this article, we highlight five common clinical scenarios and relevant articles of original research that, if read, understood, and properly transmitted during clinical encounters, can change how our patients (and their caregivers) view their diagnosis, consequent treatment, and impact of their behavior. While there are limited scientific data to support the assertion that clinical care is enhanced by integration of neuroscience research, it seems intuitive that given the barrage of brain scans in the media, patients and families expect their providers to be literate in relevant neuroimaging studies. Certainly, the developers of curricula for psychiatric training and writers of boards and maintenance of certification exams have this expectation.

To educate on this topic, we offer summaries for a select group of neuroimaging-informed topics that can help child and adolescent psychiatrists address common clinical questions. Similar high-quality, clinically-relevant imaging studies are increasingly easy to locate in our field's top journals. This list will likely grow rapidly in the future.

### TOPIC 1: WILL MEDICATIONS FOR ATTENTION-DEFICIT/HYPERACTIVITY DISORDER (ADHD) ALTER MY CHILD'S BRAIN?

Shaw and colleagues[1] examined cortical thickness changes between age 12 and 16 in a group of 43 adolescents with ADHD. The thickness of the brain's cortex is a relatively stable measure of brain development over time and grows in predictable ways. Fifty-six percent of the adolescents took stimulant medications during those intervening four years, while the rest did not.

> "...Stimulant medications do not appear to harm brain development and may even promote more normal growth patterns in youth with ADHD."

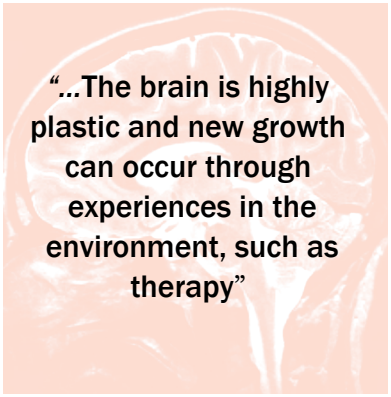
When discussing this study with our patients, we could begin by explaining the caveat that this, like all studies, needs replication with a larger sample and has limitations, including the limitation that this was a research study and was not using a clinical population. We could then explain that the brain's cortex normally thins out across this period in adolescent development, and that Shaw and colleagues found more rapid thinning in the group of adolescents with ADHD who did not take psychostimulants compared to those with ADHD who did. Compared to brain scans of typically developing adolescents and those on medications, those off medications had more abnormalities in their brain development, suggesting that medications may cause brain development to occur more typically in teens with ADHD. Finally, and perhaps most importantly, the authors did not find slowed growth or damage to the cortex attributable to stimulant treatments. This work suggests that cortical development approximates normal development more closely when stimulant medications are taken during this period in adolescence.

**Summary:** Patients and their families can be educated that existing research suggests that stimulant medications do not appear to harm brain development and may even promote more normal growth patterns in youth with ADHD.

HOME

### TOPIC 2. MY CHILD WAS ABUSED SEVERAL YEARS AGO BUT IS IN A SAFE ENVIRONMENT NOW. WHY IS HE/SHE STILL SO TROUBLED?

Many of the youth in psychiatric care have been maltreated. The current diagnostic system leaves us partitioning these children's dysregulated affect and behavior into disorders that may not fully capture their problems and ignores their complex etiology. Families caring for these children (sometimes extended family, foster, or adoptive parents) struggle to understand why children who have been in a safe, secure environment for years may still have significant psychopathology. Recently, Whittle et al., along with other research groups, demonstrated what clinicians and scientists have speculated for decades: "Childhood maltreatment was associated with altered brain development during adolescence."[2]




In Whittle's sample, hippocampus and amygdala volume differences were attributed to childhood maltreatment, and continued abnormal development was associated with the development of psychopathology throughout childhood and adolescence. A cascade of toxic stress initiated in childhood has long-term effects on brain development and cannot simply be erased when the stress has been removed. Although this sounds like bleak news, we can help our patients and their families realize that many children who have suffered from trauma may experience longstanding difficulties.

These youth may have biological etiologies (i.e., limbic circuit abnormalities) that help to explain the problems they see. For some it may be helpful to realize that there is a reason for the ongoing difficulties, while others may be discouraged, feeling that their child's behavior has been determined by his or her neurobiological defects. For the latter, it is important to follow up with the concepts discussed below in Topic 3, regarding the impact of treatment in shaping brain structure and function.

**Summary:** The size of regions in the brain's emotional center appear to be impacted by early life maltreatment, which continues long after the trauma has ended, and these abnormalities in brain region size may be related to the development of psychiatric symptoms.

### TOPIC 3. DOES THERAPY REALLY MATTER?

Even as many studies in adults have demonstrated brain changes associated with psychotherapy, far fewer have approached this issue in children or adolescents. Convincing a family that a behavioral intervention or psychotherapy can actually change their child's brain function and/or structure may motivate them to begin treatment, rationalize psychotherapy before starting a medication, or motivate the child that the work he or she is doing in therapy is important because it can create positive, long-lasting changes in the brain. For decades, neuroscientists believed that once development occurred, neurons did not continue to grow. More recently, many experiments in animals and humans have discovered that the brain is highly plastic, and new growth can occur through experiences in the environment, such as therapy.

Showing an image from Geraldine Dawson's study[3] on brainwave responses (through electroencephalography, or EEG) to intensive behavioral interventions delivered to 18-30 month olds with autism may also inspire a family to begin treatment earlier and with greater intensity. The notion that non-pharmacologic interventions have neurobiological effects is a powerful message. As with diagnosis, it is important to emphasize that assessments like EEG and magnetic resonance imaging (MRI) are not able to show improvements for individual patients and are still only useful in the context of research. This type of information may inspire families who see their child as "broken" to begin to conceptualize the child as having the potential to change with treatment.

**Summary:** Intensive behavioral interventions in toddlers with autism were associated with changes in brain waves before and after treatment, as measured by EEG recordings.

### TOPIC 4. THEY ONLY DRINK ON WEEKENDS. HOW BAD COULD IT REALLY BE?

Binge drinking is a developmentally normative albeit potentially dangerous practice among adolescents. It comes as no surprise to psychiatric practitioners that excessive alcohol consumption can lead to brain damage, but teens and their families are very unlikely to realize the true impact binge drinking can have on brain development. McQueeney and colleagues' study[4] shines light on the dramatic impact of even occasional binge drinking on brain structure. In this study, 28 adolescents who did not meet criteria for any substance use disorder were divided into two groups: those who have a history of binge drinking and those who do not. The binge-drinking group had

changes in the brain's white matter in over 18 different regions. White matter helps signals travel efficiently from region to region, and this work suggests that inefficiencies in this process are present throughout the brain among adolescent binge drinkers. Discussing this finding with youth may provoke a defensive response, but when presented in a non-judgmental, informative style, this type of information could compel some to reconsider this practice. Reviewing these findings with parents can elevate their concern about binge drinking and can be a teaching point about the importance of parental monitoring.

**Summary:** Even among teens who do not meet criteria for alcohol use disorders, binge drinking is implicated in damaging the white matter tracts throughout the brain.

### TOPIC 5. IS THERE REALLY ANY DIFFERENCE BETWEEN TEMPER OUTBURSTS AND BIPOLAR MANIA?

Parsing childhood mania and temper outbursts can be challenging. Neurobiological evidence suggesting differences in brain functioning add weight to the argument that chronic temper outbursts and the related irritability (e.g., severe mood dysregulation) are distinct from episodes of mania. Brotman and colleagues used functional MRI to compare groups of children with bipolar disorder, severe mood dysregulation, ADHD, and healthy comparisons on a task involving pictures of faces.[5] Amygdala activation in the severe mood dysregulation group differed from all three of the other groups while performing the task.

These findings help differentiate diagnoses that are clinically difficult to tease apart. Discussing research findings with patients can highlight the notion that even though symptoms may seem similar on paper, brain activity is likely quite different between episodically and chronically irritable children. These brain differences have tremendous implications for the uniqueness of treatments and courses of these disorders.

**Summary:** Amygdala activation patterns differ between children with bipolar disorder and severe mood dysregulation. These differences suggest bipolar disorder and severe mood dysregulation are distinct disorders likely requiring unique treatments, despite similar symptoms.

### Conclusions

In conclusion, each of these research articles provides information on brain structure or function that can be explained in clinical settings. As discussed, neuroimaging findings can be used clinically for patients and parents alike to allay fears, explain symptomatology, motivate for treatment, and demonstrate potential harm of certain behaviors, among other possibilities. Ultimately, brain imaging research seeks to identify biological targets and elucidate fundamental mechanisms (Priority Areas; NIMH.NIH.GOV), but prior to that time, there are a number of clinical functions this work can serve. Informing ourselves about neuroscience research is a valuable and necessary addition to our ongoing learning and patient care.

*Take-Home Summary:*

**Neuroimaging studies are relevant to practicing clinicians as they have the potential to inform treatment decisions and warrant discussion with patients and families. The above examples provide a template for describing neuroimaging findings in the clinical setting.**

### References

1. Shaw P, Sharp WS, Morrison M, *et al*. Psychostimulant treatment and the developing cortex in attention deficit hyperactivity disorder. *Am J Psychiatry*. 2009; 166(1):58–63.
2. Whittle S, Dennison M, Vijayakumar N, *et al*. Childhood maltreatment and psychopathology affect brain development during adolescence. *J Am Acad Child Adolesc Psychiatry*. 2013; 52(9):940–952.
3. Dawson G, Jones EJ, Merkle K, *et al*. Early behavioral intervention is associated with normalized brain activity in young children with autism. *J Am Acad Child Adolesc Psychiatry*. 2012. 51(11):1150-9.
4. McQueeny T, Schweinsburg BC, Schweinsburg AD, *et al*. Altered white matter integrity in adolescent binge drinkers. *Alcohol Clin Exp Res*. 2009; 33(7): 1278–85.
5. Brotman MA, Rich BA, Guyer AE, *et al*. Amygdala activation during emotion processing of neutral faces in children with severe mood dysregulation versus ADHD or bipolar disorder. *Am J Psychiatry*. 2010;167(1):61-9.

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